National Institute of Environmental Health Sciences

Development of impact factors on damage to health by infectious diseases caused by domestic water scarcity

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Abstract:

Background, aim, and scope: Water scarcity is a critical environmental issue. In particular, domestic water is a necessary resource for our fundamental activities, and poor water quality may lead to damage to health caused by infectious diseases. However, there is no methodology to assess the damage of domestic water scarcity (low accessibility to safe water) caused by water consumption. The main objectives of this study are to model the health damage assessment of infectious diseases (ascariasis, trichuriasis, hookworm disease, and diarrhea) caused by domestic water scarcity and calculate damage factors on a country scale. Materials and methods: The damage to health caused by infectious diseases was assumed to have resulted from domestic water scarcity due to loss of accessibility to safe water. Damage function of domestic water scarcity was composed of two steps, including assessments of water accessibility and health damage. This was modeled by applying regression analyses based on statistical data on a country scale. For more precise and realistic modeling, three explanatory variables (domestic use of fresh water, gross domestic product per capita and gross capital formation expenditure per capita) for water accessibility assessment and seven explanatory variables (the annual average temperature, the house connection to water supply, the house connection to sanitation, average dietary energy consumption, undernourished population rate, Gini coefficient of dietary energy consumption, and health expenditure per capita) for the health damage ssessment were chosen and non-linear multiple regression analyses were conducted. Results: Water accessibility could be modeled by all three explanatory variables with sufficient explanatory power (R 2∈Euro Surveillance (Bulletin Europeen Sur Les Maladies Transmissibles; European Communicable Disease Bulletin)∈0.68). For the health damage assessment, significant explanatory variables were different from those for diseases, but the R 2 values of the regression models for each infectious disease were calculated as more than 0.4. Furthermore, the house connection to water supply rate showed a high correlation with every infectious disease. This showed that domestic water scarcity is strongly linked to health damage caused by infectious diseases. Based on the results of the regression analyses, the calculated damage factors of domestic water scarcity ranged from 1.29E-11 to 1.81E-03 [Disability Adjusted Life Years (DALYs)/m3], and the average value (weighted mean value by domestic use of fresh water for each country) was 3.89E-07 [DALYs/m3] and the standard deviation of damage factors was 1.40E-07 [DALYs/m3]. Discussion: According to the calculated damage factors for each country, countries sensitive to domestic water scarcity appeared to be located in the African region, and in addition, the amount of available domestic water tended to be less in the most sensitive countries. Water production technologies represented by desalination are expected to be a countermeasure for the reduction of water

stress. As an example of the application of damage factor analysis, health damage improvement compared with the effects of CO2 emission caused by the introduction of desalination plants showed that there were several countries where desalination was worth introducing after considering the advantages and disadvantages of the environmental impact. Conclusions: Damage assessment models of domestic water scarcity were developed by applying non-linear multiple regression analysis. Damage factors could be calculated for most countries, except for those without statistical data for the analysis. Damage factors are applicable to not only the assessment of water consumption, but also the evaluation of benefits of water production in countries suffering from water scarcity. Recommendations and perspectives: The analyses of this study were conducted by applying data on a country scale, and the regional and local characteristics within each country are expected to be taken into account in future studies. The water resource amount, which was represented by the amount of domestic use of fresh water in thi study, should be estimated with consideration of the effects due to climate change. © 2010 Springer-Verlag.

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Resource Description

Exposure :

weather or climate related pathway by which climate change affects health

Food/Water Quality, Food/Water Security, Food/Water Security, Temperature

Food/Water Security: Food Access/Distribution, Nutritional Quality

Temperature: Fluctuations

Geographic Feature:

resource focuses on specific type of geography

None or Unspecified

Geographic Location:

resource focuses on specific location

Global or Unspecified

Health Co-Benefit/Co–Harm (Adaption/Mitigation):

specification of beneficial or harmful impacts to health resulting from efforts to reduce or cope with greenhouse gases

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Health Impact:

specification of health effect or disease related to climate change exposure

Infectious Disease, Morbidity/Mortality

Infectious Disease: Foodborne/Waterborne Disease

Foodborne/Waterborne Disease: Other Diarrheal Disease

Foodborne/Waterborne Disease (other): Ascariasis, Trichuriasis, Hookworm disease

Mitigation/Adaptation: ☑

mitigation or adaptation strategy is a focus of resource

Adaptation

Resource Type: ☑

format or standard characteristic of resource

Research Article

Timescale: ☑

time period studied

Time Scale Unspecified

Vulnerability/Impact Assessment: ☑

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

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